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RECOMMENDER SYSTEMS BASED ON HYBRID MODELS

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Abstract: Recommender Systems (RSs) play a very important role in web navigation, ensuring that the users easily find the information they are looking for. Today's social networks contain a large amount of information and it is necessary that they employ mechanism that will guide users to the information they are interested in. However, to be able to recommend content according to user preferences, it is necessary to analyse their profiles and determine their preferences. The present study presents the work related to different recommender systems focused on two different hybrid models. Both of them are using a Case-Based Reasoning (CBR) system combined with the training of an Artificial Intelligence (AI) algorithm. First, some information is analyzed and trained with an AI algorithm in order to determine relevant patters hidden on the information. Then, the CBR system extends the system using a series of metrics and similar past cases to decide whether the recommendation is likely to be recommended to a user. Finally, the last step on the CBR is to propose recommendations to the final user, whose job is to validate or reject the proposal feeding the cases database.

Keywords: Recommender Systems; Artificial Intelligence; Case-Based Reasoning; Social Networks.

1 Introduction

The role social networks play in our daily lives is probably greater than we realize. We often see them as simple communication and content-sharing

tools, those, of course, are their main functions. However, social networks have come to be much more than that; they customize advertisements to suit our tastes and they even help us find a job [4]. Social networks provide such advanced features thanks to the collection and analysis of the data users generate on the Internet [1] [5]. Career-oriented social networks enjoy a particularly high success rate, some well-known platforms include Monster, XING, LinkedIn or beBee [2]. Following a different approach, a recommender system can be designed and developed using the information obtained from Virtual Learning Environments (VLEs). According to the information gathered, a platform like Moodle can be modified in order to give recommendations to their students [10-21]. In the next sections two case studies are described. The first case is a work related to social networks in which individual job recommendations are given based on the preferences and the profile of a particular user on social networks. The second case is using data from a VLE platformm, and the main goal is study the variables to determine the principal factors that affect to the final results of students [22-33].

2 Job offer recommender system

The research presented in this case study focuses on a relationship recommendation system for a business and employment-related social network called beBee [6]. On beBee, companies and users share content, and users search for and apply to the published job offers. Therefore, in the case of this social network, the recommender system will not only serve for connecting similar user profiles but also for providing work related suggestions to users and companies.

For this purpose, we identify different factors that could be extracted from the information provided by users and we analyzed the information found in the published job offers. One of the challenges that we had to address was the extraction of information, since the required information is often not available or it is not properly structured. Thus, it was necessary to apply text mining and information extraction techniques in order to evaluate possible ties between users as well as users and job offers [34-47].

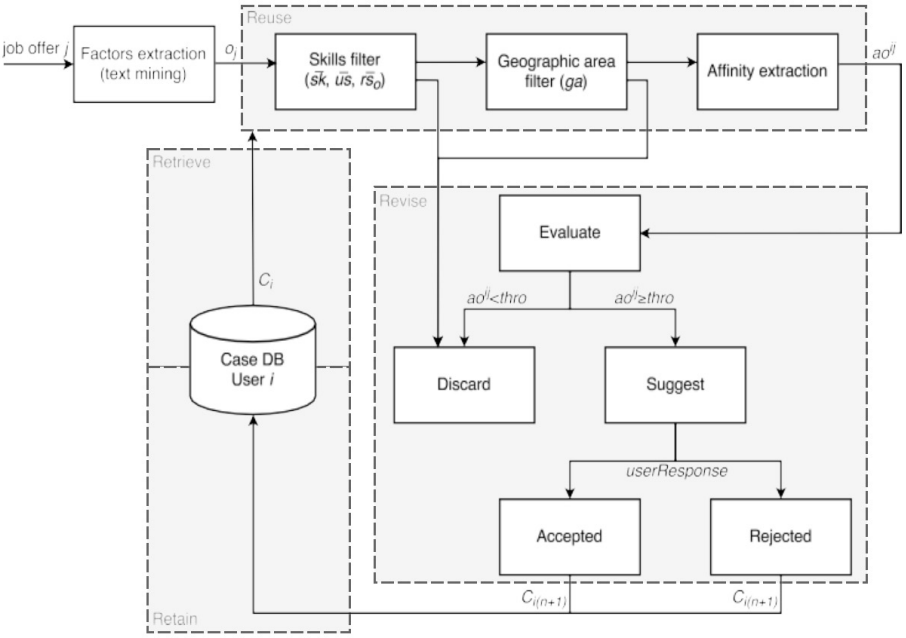

Figure 1. Job offer recommendation system flowchart and CBR parts.

These techniques ensure that the job offers recommended to users, correspond to the information provided in their profile; they possess the skills required by the offer, they have been previously interested in similar offers, etc. However, the use of these techniques does not guarantee that the offer suggested by the system, satisfies all user expectations.

To provide accurate suggestions, it is important to analyze the reasons for which a particular user could reject or accept a suggestion. To do such an analysis, it is necessary to employ techniques such as case-based reasoning (CBR), which allows to feedback the system with information on previous cases [7]. CBR is a problem solving methodology and its use in this project is essential since it will allow the recommender system to learn and improve over time by re-using similar past experiences which are stored in cases. The one proposed in the case study follows the flow described in the Figure 1.

To evaluate the proposed system it has been divided into two parts: user-user relationships and user-job offer relationships. Different

subsets of real and active users, as well as recently published job offers, have been selected to gather information for this evaluation. The results obtained in this evaluation are satisfactory [48-56].

3 Resources recommender system based on the students performance

The objective of this case of study is to give some recommendations to the students aiming for increase exam pass rate through the evaluation of an automatic learning model and its subsequent improvement. The system proposed in Figure 2 has been designed for this purpose; an Artificial Neural Network (ANN) is trained with data in order to make it capable of identifying patterns of behaviour. Subsequently, the initial data set is analyzed and the parameters that contribute to students failing their exams are minimized to increase the pass rate. Finally, the already trained network is used in order to predict if with the modifications made in the parameters are going to help students to pass their exams.

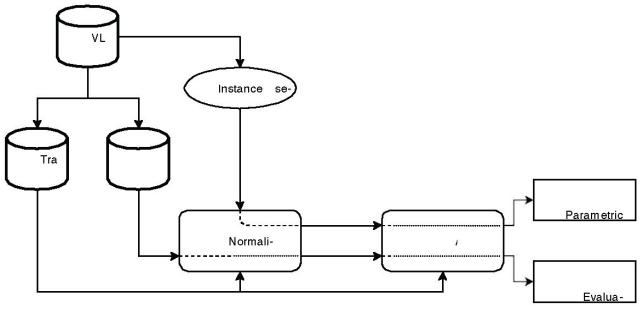

Figure 2. System workflow.

Due to data protection, the processing of data may be a complicated process, as a result, it was decided to work and apply a set of public data that can be accessed at [3]. The dataset contains a group of students who have participated in a series of four online courses, resulting in a total of 32, 593 students. It includes the students' personal data such as their identification code, the students' gender, region, educational level, age range, neighborhood crime rate (IMD), number of times they have previously participated in the course, enrolled credits, disability and the

final exams result (passed/failed) [57-67]. In addition, the number of times the student clicked on any of the online course contents has been counted throughout the course.

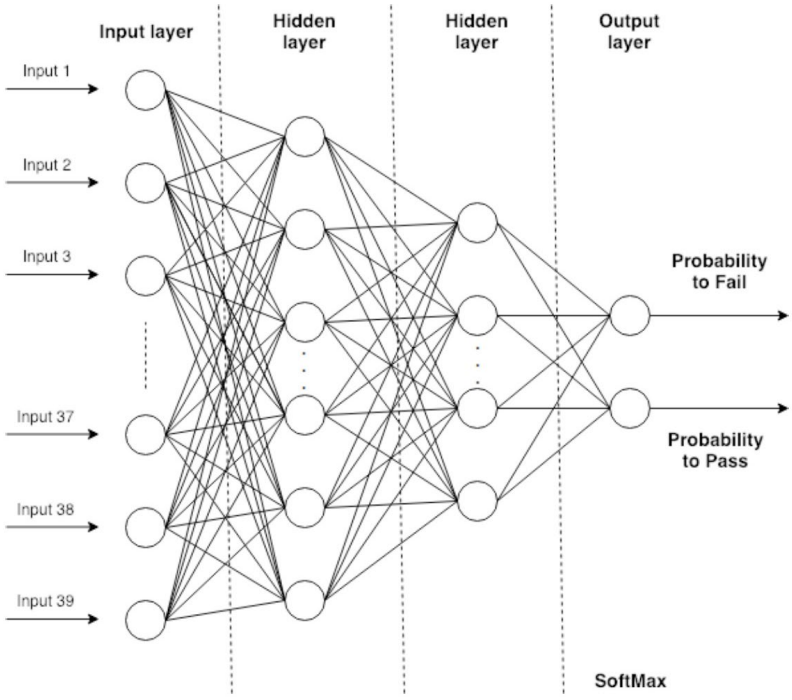

Figure 3. Design of the multilayer perceptron.

About the ANN, the proposed system architecture is based on a multilayer perceptron (MLP) with up to two hidden layers with a previously fixed size, as shown in Figure 3. The activation function of the neurons in the hidden layer is selected among three choices: the Rectified Linear Unit function,

$$relu(z) = \max(0, z) \qquad (1)$$

the logistic sigmoid function, and the hyperbolic tangent function, tanh. The procedure for choosing these hyperparameters of the network, such as the number of neurons in the hidden layers or the activation function, a 5-fold cross validation procedure was carried in the

training set. The mean accuracy is then used to compare the different network topologies [68-75].

Apart from those hidden layers, the input layer has as many neurons as there are inputs in the data set, while the output layer has 2 neurons with a SoftMax activation function, ideal for classification problems as it scales actual values in the range of [76-86]. The first neuron in the output layer is the probability that a student is going to fail, while the second is the probability that a student is going to pass the course.

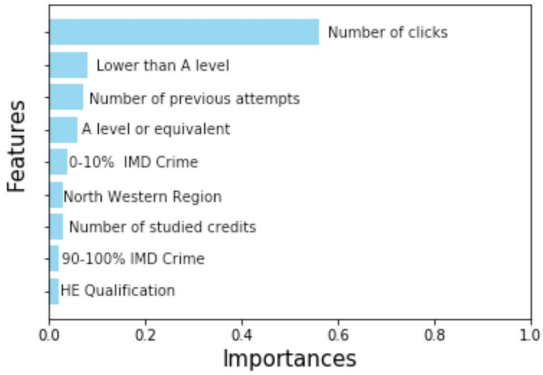

Figure 4. Weight of parameters

The logarithmic loss has been used to optimize the weights of the network, providing a more nuanced view into its performance than the accuracy. To minimize the processing costs of the algorithm, an optimization method has been leveraged. Specifically, the Adam optimizer [8] designed to train Deep Neural Networks, has been used with 500 epochs and a batch size of 30.

Regarding the results, it can be seen that the user intersection with the contents displayed in the VLE is really significant as Figure 4 shows, being the number of click the most important feature amongst the other ones. Based on this study, next step will be to study the resources available in the platform in order to figure out the most relevant ones for each user []76. Once this study will be done, the most interesting aspect to include is to display better positioned in the VLE the most important resources to facilitate the final user the interaction with them.

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